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New Application 08/807694

INTERNATIONAL APPLICATION NO.

PCT/JP00/05598

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PRIORITY DATE CLAIMED

August 24, 1999

TITLE OF INVENTION

RADIO RECEPTION APPARATUS AND RADIO RECEPTION METHOD

APPLICANT(S) FOR DO/EO/US

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Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
  - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☒ has been transmitted by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
  - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ have been transmitted by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

## Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Claim for Priority with PCT/IB/304

PCT/IB/308

PCT/RO/101

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.492(a)(1) - (5)) : <b>New Application</b> <b>09/807694</b>		INTERNATIONAL APPLICATION NO. <b>PCT/JP00/05598</b>		ATTORNEY'S DOCKET NUMBER <b>L9289.01132</b>	
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21. The following fees are submitted:				<b>CALCULATIONS PTO USE ONLY</b>	
<b>BASIC NATIONAL FEE ( 37 CFR 1.492 (a) (1) - (5)) :</b> <input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... <b>\$1,000.00</b> <input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... <b>\$860.00</b> <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... <b>\$710.00</b> <input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... <b>\$690.00</b> <input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) ..... <b>\$100.00</b>  <b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>				<b>\$860.00</b>	
Surcharge of <b>\$130.00</b> for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				<b>\$0.00</b>	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	10 - 20 =	0	x \$18.00	<b>\$0.00</b>	
Independent claims	6 - 3 =	3	x \$80.00	<b>\$240.00</b>	
Multiple Dependent Claims (check if applicable). <input type="checkbox"/>				<b>\$0.00</b>	
<b>TOTAL OF ABOVE CALCULATIONS =</b>				<b>\$1,100.00</b>	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable). <input type="checkbox"/>				<b>\$0.00</b>	
<b>SUBTOTAL =</b>				<b>\$1,100.00</b>	
Processing fee of <b>\$130.00</b> for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				<b>\$0.00</b>	
<b>TOTAL NATIONAL FEE =</b>				<b>\$1,100.00</b>	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input checked="" type="checkbox"/>				<b>\$40.00</b>	
<b>TOTAL FEES ENCLOSED =</b>				<b>\$1,140.00</b>	
				<b>Amount to be: refunded</b>	<b>\$</b>
				<b>charged</b>	<b>\$</b>

- ☒ A check in the amount of **\$1,140.00** to cover the above fees is enclosed.
- ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \_\_\_\_\_ to cover the above fees.  
A duplicate copy of this sheet is enclosed.
- ☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **19-4375** A duplicate copy of this sheet is enclosed.

**NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.**

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**April 17, 2001**

DATE

5/PR4

# DESCRIPTION

## RADIO RECEPTION APPARATUS AND RADIO RECEPTION METHOD

### 5 Technical Field

The present invention relates to a radio reception apparatus and radio reception method used in a digital radio communication system.

### 10 Background Art

A CDMA (Code Division Multiple Access) is one of multiple-access system technologies when a plurality of stations simultaneously carries out communications on a same frequency band in mobile communications such as automobile telephones and cellular telephones. Other known technologies include an FDMA (Frequency Division Multiple Access) system, a TDMA (Time Division Multiple Access) system, etc. Compared to these technologies, the CDMA system provides higher frequency utilization efficiency and larger channel capacities to accommodate more users.

In the CDMA system, limits of a channel capacity are determined by interference from other users in the own cell or neighboring cells. Therefore, to increase the channel capacity, interference must be reduced in some way. An example of processing to reduce interference is a canceller.

An interference canceller includes a single user

type (SUD: Single User Detection) and multi-user type (MUD: Multi User Detection). The single user type is a system of executing the interference canceller using only spreading codes and reception timing of the own station. A typical example of such SUD is an orthogonal filter that adaptively controls a tap coefficient of a matched filter so as to be orthogonal to the spreading code of an interference signal. The SUD has a simpler configuration and shows higher feasibility than the MUD, but it is difficult to apply the SUD in a multi-path environment where the symbol cycle does not match the cycle of the spreading code, for example, in the case where a long-cycle spreading code such as a scramble code is used. This is because when the scramble code is in place, the influence of mutual correlations caused by multi-paths varies from one symbol to another preventing the coefficients of the orthogonal filter from converging.

On the other hand, the MUD is a system for executing the interference canceller by making a data decision after estimating amplitudes and phases of reception signals of all users based on spreading codes of all users engaged in communications and all reception timing information. This system is free of restrictions by cycles of spreading codes.

As the MUD, a multi-stage interference canceller is proposed ("Channel Estimation Successive Update Type DS-CDMA Coherence Multi-Stage Interference Canceller

Using Pilot and Data Symbols", by Sawabashi, Andoh, Higuchi, IEICE RCS 96-100), which generates interference replicas of other users based on reception fading complex envelope and decision data estimated on the receiving side, subtracts these interference replicas from the reception signals and thereby improves an SIR (Signal to Interference Ratio) with respect to subsequent users thus improving the reception characteristics.

In a CDMA system represented by W-CDMA, an interference canceller mounted on a communication terminal (UE: User Equipment) such as a mobile station needs to perform correlation calculations on signals of all users, which increases the hardware scale. Moreover, such an MUD needs to know all spreading codes and transmission timings of targets of the canceller, which increases the amount of communication and load.

On the other hand, as a packet communication according to a CDMA system, there is a method of carrying out communication by time-sharing a common spreading code having a high transmission rate. An example of this is a DSCH (Downlink Shared CHannel). Such a packet communication has a high symbol rate and transmits data with high transmit power, and therefore when viewed from the standpoint of interference, interference per channel is considerably greater than a voice channel.

Furthermore, compared to a channel exchange type of continuous communication, such a packet communication often has an asymmetric amount of transmission between

the uplink and downlink, and since a burst signal is used, estimating the arrival direction by only receiving a short-time burst signal requires a system with high-speed convergence performance, which generally makes it difficult for a base station to apply high precision transmission with directivity. This increases a probability that the packet communication will constitute great interference to the entire area to be covered.

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#### Disclosure of Invention

It is an object of the present invention to provide a radio reception apparatus and radio reception method capable of improving the reception characteristics by canceling interference, and more particularly, by canceling interference caused by high-speed packets on the downlink.

A spreading code used for a common control channel needs to be demodulated, and therefore becomes known to a communication terminal. In a packet communication, too, in the case of the DSCH above, spreading codes used are limited. If this spreading code is already known, it is not necessary to inform other communication terminals of the spreading code.

The present inventor has focused on the above fact and has come up with the present invention by discovering that it is possible to improve the reception characteristics with a small hardware scale by executing

an interference canceller only on a specific spreading code.

That is, an essence of the present invention is to detect a reception signal spread/modulated by specific spreading codes from the reception signal and perform interference canceller processing on the detected reception signal.

The specific spreading codes are known as described above or one or several spreading codes are notified through transmission. Even if the spreading codes are not known, it is not necessary to transmit spreading codes of all users as in the case of conventional arts, and therefore notification is easier.

#### 15 Brief Description of Drawings

FIG.1 is a block diagram showing a configuration of a radio reception apparatus (communication terminal apparatus) according to Embodiment 1 of the present invention;

20 FIG.2 is a block diagram showing a channel estimation/replica generation section in the communication terminal apparatus above;

FIG.3 is a drawing to explain timing of level detection by the communication terminal apparatus above;

25 FIG.4 is a block diagram showing a configuration of a radio reception apparatus (base station apparatus) according to Embodiment 2 of the present invention; and

FIG.5 is a drawing to explain timing of level

detection by the base station apparatus above.

#### Best Mode for Carrying out the Invention

With reference now to the attached drawings,  
5   embodiments of the present invention will be explained  
in detail below.

(Embodiment 1)

FIG.1 is a block diagram showing a configuration  
of a radio reception apparatus (communication terminal  
10   apparatus) according to Embodiment 1 of the present  
invention.

A signal transmitted from a base station is received  
by radio reception section 102 via antenna 101. Radio  
reception section 102 performs various kinds of  
15   processing such as amplification (gain control),  
down-conversion and A/D conversion on the reception  
signal. The signal subjected to such processing is sent  
to matched filter 103, where the signal is subjected to  
a correlation calculation using the spreading code used  
20   for spreading processing on the transmitting side.

The correlation value obtained by the correlation  
calculation is integrated for a predetermined period and  
sent to level detection section 104. Level detection  
section 104 performs level detection on the integrated  
25   correlation value. For example, level detection is  
performed by comparing the integrated correlation value  
with a threshold.

The result of this level detection is sent to ON/OFF



control section 105. ON/OFF control section 105 controls ON/OFF switching of switches (SW) 106, 107a and 107b according to the level result. This ON/OFF switching makes it possible to control

5 execution/non-execution of interference canceller processing.

Interference cancellers 109 and 110 are multi-stage type interference cancellers and constructed of a series of stages each including a delayer and  
10 interference canceller unit. Delay section 108 is a memory to delay a reception signal so that processing is carried out by an interference canceller at each stage. At each stage, a replica of a signal which becomes interference is created and interference is removed by  
15 subtracting this replica from the reception signal. This allows reception data to be obtained with an SIR (signal to interference ratio) improved.

By the way, the interference canceller shown in FIG.1 is constructed by connecting 1st stage 109 and 2nd  
20 stage 110, but the interference canceller can also be constructed by connecting three or more stages.

Interference cancellers 109 and 110 each have a plurality of processing lines and each processing line includes delayers 1091 and 1101, subtractors 1092 and  
25 1102 and channel estimation and interference generation units (hereinafter referred to as "CEIGU") 1093 and 1103. By the way, since the 1st stage processing line of 1st stage interference canceller 109 has no signal to be

subtracted, no subtractor 1092 is provided.

CEIGU 1093 and 1103 have a configuration as shown in FIG.2. The CEIGU includes channel estimation unit 201 that carries out channel estimation, replica generation  
 5 unit 202 that generates an interference replica using a signal subjected to data decision, RAKE combining section 203 that RAKE-combines the channel-estimated signal and data decision section 204 that carries out a data decision on the RAKE-combined signal.

10 CEIGU 1093 and 1103 are provided with a plurality of channel estimation units 201 and replica generation units 202 according to the number of their respective multi-path reception delay waves, that is, the number of paths, and therefore CEIGU 1093 and 1103 can generate  
 15 interference replicas corresponding to each multi-path reception delay wave. The output on the lowermost processing line at each stage is demodulated data.

Channel estimation unit 201 includes matched filter 2011 that performs despreading processing on the  
 20 received wave, channel estimation section 2013 that carries out channel estimation of a path and multiplier 2012 that multiplies a despreading signal, which is the matched filter output, by a complex conjugate of the channel estimation value estimated by channel estimation  
 25 section 2013.

Replica generation unit 202 includes multiplier 2021 that multiplies the data symbol after data decision by the channel estimation value obtained by channel

estimation section 2013 and replica generation section 2022 that generates an interference replica by applying spreading processing to the data multiplied by the channel estimation value using the spreading code used  
5 by matched filter 2011 again.

On the other hand, the transmission data is digital-modulated by modulation section 111 and sent to spreading section 112. Spreading section 112 performs spreading modulation processing on the transmission data  
10 using a predetermined spreading code. This spread/modulated signal is sent to radio transmission section 113, where the signal is subjected to various kinds of processing such as amplification (gain control), up-conversion and D/A conversion. The signal subjected  
15 to such radio transmission processing is sent from antenna 101.

Then, the operation of the radio reception apparatus (communication terminal apparatus) in the configuration above will be explained.

20 First, a case where the communication terminal executes the interference canceller on a spreading code used for a common control channel will be explained. The common control channel signal needs to be demodulated by the communication terminal, and therefore is sent from  
25 the base station with a relatively high level. Therefore, the common control channel signal can be identified by monitoring the reception level at the communication terminal. Thus, interference canceller processing is

performed on this spreading code using the spreading code used for the common control channel as the specific spreading code.

The received common control channel signal (target spreading code) is subjected to predetermined radio reception processing and sent to matched filter 103, where the signal is despread using a known spreading code used for the common control channel. A correlation value resulting from despreading processing is integrated for a predetermined period and the integrated value is sent to level detection section 104.

Level detection section 104 performs level detection processing on the input integrated value. For example, level detection section 104 compares the integrated value with a predetermined threshold and sends the comparison result to ON/OFF control section 105. Thus, it is possible to extract a signal spread/modulated with a specific spreading code from the reception signal by performing level detection in this way.

Upon acquiring a comparison result that the integrated value exceeds the predetermined threshold, ON/OFF control section 105 turns ON switches 106, 107a and 107b and performs interference canceller processing on the reception signal. At this time, switch 107a is switched so that the reception signal is sent to 1st stage interference canceller 109, switch 106 is switched so that the reception signal is sent to 2nd stage

interference canceller 110 and switch 107b is switched so that the reception signal is not sent directly to the CEIGU 1093 on the lowermost processing line.

On the other hand, upon acquiring a comparison  
5 result that the integrated value falls below the  
predetermined threshold, ON/OFF control section 105  
turns OFF switches 106, 107a and 107b and demodulates  
the reception signal without performing interference  
canceller processing. At this time, switch 107a is  
10 switched so that the reception signal is not sent to 1st  
stage interference canceller 109, switch 106 is switched  
so that the reception signal is not sent to 2nd stage  
interference canceller 110 and switch 107b is switched  
so that the reception signal is sent directly to the CEIGU  
15 1093 on the lowermost processing line.

When this ON/OFF control is performed, a delay is  
generated by decision processing using level detection,  
and therefore it is necessary to temporarily store the  
reception signal in memory in the meantime, but since  
20 storage processing is indispensable in the MUD  
processing and this is not a big problem.

When interference canceller processing is  
performed, the reception signal is input to 1st stage  
interference canceller and processed on the processing  
25 line at each stage. The sequence of stages (sequence  
from the top stage to bottom stage) is determined in  
descending order according to the reception level, for  
example.

On the 1st stage processing line of 1st stage interference canceller 109, the reception signal is sent to CEIGU 1093 via delayer 1091. CEIGU 1093 performs channel estimation on another user channel with the  
5 highest level and generates a replica signal of this other user channel using the result of the channel estimation.

More specifically, the signal of the 1st other user channel signal is sent to channel estimation unit 201  
10 of CEIGU 1093 for every delay wave. In channel estimation unit 201, matched filter 2011 performs despread processing on the 1st other user channel signal and obtains a reception symbol. By the way, the spreading code used for despread processing, that is,  
15 the spreading code of the 1st user channel is known to the communication terminal.

The reception symbol obtained by despread processing is sent to channel estimation section 2013. Channel estimation section 2013 performs channel  
20 estimation of the 1st other user channel using a known signal such as a pilot symbol and obtains a channel estimation value. Then, multiplier 2012 performs coherent detection by multiplying the reception symbol above by a complex conjugate of this channel estimation  
25 value. Then, their respective reception symbols are sent to RAKE combining section 203.

RAKE combining section 203 RAKE-combines a reception symbol for every delay wave and sends the

RAKE-combined reception symbol to data decision section 204. Data decision section 204 performs data decision on the RAKE-combined reception symbol and obtains a data symbol. On the lowermost processing line at the final stage, the output of data decision section 204 is demodulated data.

The data symbol subjected to data decision is multiplied by a channel estimation value obtained from channel estimation section 2013 of their respective channel estimation units 201 according to the delay wave by multiplier 2021 of replica generation unit 202 separated at timing of each delay wave.

The multiplied symbols are sent to replica generation section 2022 and subjected to re-spreading/modulation processing using the spreading code used by matched filter 2011. The re-spread/modulated signals obtained in this way are combined into an interference replica signal ( $S1(1)$ ) of the 1st other user channel.

The interference replica signal  $S1(1)$  of this 1st other user channel is used on the 2nd processing line of 1st stage interference canceller 109. On the 2nd processing line, the reception signal is sent to subtractor 1092 via delayer 1091. There, the interference replica signal of the 1st other user channel is subtracted from the reception signal. The interference component of the 1st other user channel is removed from the reception signal in this way.

The reception signal stripped of the interference component of this 1st other user channel is sent to CEIGU 1093 and CEIGU 1093 performs processing similar to the processing above to obtain an interference replica  
 5 signal ( $S_2(1)$ ) of the 2nd other user channel.

The interference replica signals of the 1st and 2nd other user channels are used on the processing lines at and after the 3rd stage of the 1st stage interference canceller 109. On the processing lines at and after the  
 10 3rd stage, the reception signal is sent to subtractor 1092 via delayer 1091 in the same way as on the processing line at the 1st and 2nd stages. There, the interference replica signals of the other user channel obtained on the processing lines up to the preceding stage are  
 15 subtracted from the reception signal. The interference components of the other user channels up to the preceding stage are removed from the reception signal in this way.

Thus, interference replica signals  $S_1(1)$ ,  $S_2(1)$ , ...,  $S_{k-1}(1)$  of other user channels are obtained through  
 20 1st stage interference canceller 109. The output of CEIGU 1093 on the lowermost-stage processing line is demodulated data. These interference replica signals  $S_1(1)$ ,  $S_2(1)$ , ...,  $S_{k-1}(1)$  and demodulated data  $S_k$  are used by 2nd stage interference canceller 110.

25 On the 1st stage processing line of 2nd stage interference canceller 110, the reception signal is sent to subtractor 1102 via delayer 1101. There, interference replica signals  $S_2(1)$ , ...,  $S_{k-1}$  and



demodulated data  $S_k$  of other user channels other than the 1st other user channel obtained at the 1st stage are subtracted from the reception signal. In this way, the interference component of other than the 1st other user channel obtained by the 1st stage interference canceller 109 is removed from the reception signal.

The reception signal stripped of the interference component of other than the 1st other user channel obtained by the 1st stage interference canceller 109 is sent to CEIGU 1103, subjected to the same processing as that described above and converted into an interference replica signal  $S_1(2)$  of the 1st other user channel.

The interference replica signal ( $S_1(2)$ ) of the 1st other user channel is used on the 2nd stage processing line of the 1st stage interference canceller 110. On the 2nd stage processing line, the reception signal is sent to subtractor 1102 via delayer 1101. There, the interference replica signal  $S_1(2)$  of the 1st other user channel obtained from the 1st stage processing line and the interference replica signals  $S_3(1), \dots, S_k(1)$  of other than the 1st and 2nd other user channels obtained by the 1st stage interference canceller 109 are subtracted from the reception signal. In this way, the interference components of the 1st other user channel at the 2nd stage interference canceller are removed from the reception signal.

The reception signal stripped of the interference components of the 1st other user channel obtained by the

2nd stage interference canceller is sent to CEIGU 1103, subjected to the same processing as that described above and converted into an interference replica signal (S2(2)) of the 2nd other user channel.

5           Such processing is carried out on each processing line and each stage, and in this way the demodulated data of the desired signal is obtained from CEIGU on the lowermost processing line at each stage.

On the other hand, when ON/OFF control section 105  
10       acquires a comparison result that the integrated value is less than the predetermined threshold and demodulates the reception signal without performing interference canceller processing, then the reception signal is directly input to CEIGU 1093 on the lowermost processing  
15       line of 1st stage interference canceller 109, subjected to channel estimation and demodulation processing and converted into demodulated data.

As shown above, the present invention monitors a channel that executes the interference canceller by  
20       level detection, that is, monitors a common control channel and detects the presence or absence of a channel that executes the interference canceller (target channel) and performs interference canceller processing only when there is any target channel. That is, the  
25       present invention performs ON/OFF control of the interference canceller processing based on the detection result as to the presence or absence of the target channel. This allows interference canceller processing to be

performed only on a specific channel (common control channel). Since spreading codes used for the common control channel are known, it is easy to perform interference canceller processing.

5           Moreover, since interference canceller processing is performed only on specific spreading codes, it is possible to reduce the number of channels  $k-1$  whose interference is to be eliminated. This makes it possible to drastically reduce the hardware scale compared to  
10 conventional MUD interference cancellers. Furthermore, even if spreading codes are notified from the base station, only a small amount of communication is required for spreading code notification.

          On the other hand, when interference canceller  
15 processing is performed in packet communication, the communication terminal monitors a control signal AICH (Acquisition Indication CHannel) signal or TFCI (Transport Format Combination Indicator) signal, etc. sent from the base station before or simultaneously with  
20 actual data communication or detects the presence or absence of the packet data signal itself sent with specific spreading codes, detects the arrival of a canceller target signal and thereby controls ON/OFF of the interference canceller processing.

25           That is, as shown in FIG.3, when a packet signal is communicated with a specific spreading code #0 at specific transmission timing (or reception timing), the arrival of the packet signal is detected from its level

at that timing and ON/OFF control of the interference canceller is performed. This makes it possible to perform interference canceller processing even in packet communication in the same way as that shown above. By  
5 the way, spreading codes #1 to #3 are spreading codes used for a channel exchange type signal.

The present invention is also applicable when transmission directivity control is performed using an adaptive array antenna or smart antenna. A packet signal  
10 sent with specific directivity constitutes considerable interference to a channel exchange type signal (signal communicated through a channel such as a voice signal or high-speed image transmission signal) with identical directivity.

15 Thus, as shown above, detecting the level of a packet signal using a specific spreading code and controlling ON/OFF of interference canceller processing based on the detection result allows interference canceller processing to be performed only on a packet  
20 signal transmitted with specific directivity, which constitutes considerable interference to a channel exchange type signal. As a result, interference with the channel exchange type signal can be reduced.

(Embodiment 2)

25 FIG.4 is a block diagram showing a configuration of a radio reception apparatus (base station apparatus) according to Embodiment 2 of the present invention.

A signal transmitted from a communication terminal

is received by radio reception section 402 via antenna 401. Radio reception section 402 performs various kinds of processing such as amplification (gain control), down conversion and A/D conversion on the reception signal.

5 The signal subjected to such processing is sent to matched filter 403, where the signal is subjected to a correlation calculation using the spreading code used for spreading processing on the transmitting side.

The correlation value obtained by the correlation  
10 calculation is integrated for a predetermined period and sent to level detection section 404. Level detection section 404 performs level detection on the integrated correlation value. For example, level detection is performed by comparing the integrated correlation value  
15 with a predetermined threshold.

The result of this level detection is sent to ON/OFF control section 405. ON/OFF control section 405 controls ON/OFF switching of switches (SW) 406, 407a and 407b according to the level result. Through this ON/OFF  
20 switching, execution/non-execution of interference canceller processing is controlled.

Interference cancellers 409 and 410 are multi-stage type interference cancellers and constructed of a series of stages each including a delayer and  
25 interference canceller unit. Delay section 408 is a memory to delay a reception signal so that interference canceller processing is carried out at each stage. At each stage, a replica of a signal which constitutes

interference is created and interference is removed by subtracting this replica from the reception signal. This makes it possible to obtain reception data with an improved SIR (signal to interference ratio).

5           Timing control section 414 controls timing at which a control signal such as AICH is sent to the communication terminal and timing at which level detection is performed on the reception signal.

On the other hand, the transmission data is  
10   digital-modulated by modulation section 411 and sent to spreading section 412. Spreading section 412 performs spreading/modulation processing on the transmission data using a predetermined spreading code. This spread/modulated signal is sent to radio transmission  
15   section 413, where the signal is subjected to various kinds of processing such as amplification (gain control), up-conversion and D/A conversion. The signal subjected to such radio transmission processing is sent from antenna 401.

20           Then, the operation of the radio reception apparatus (base station apparatus) in the configuration above will be explained. Here, a case where ON/OFF of interference canceller processing is controlled in a packet communication will be explained.

25           The received packet signal (target spreading code) is subjected to predetermined radio reception processing, sent to matched filter 403 and subjected to despreading processing using a known spreading code used in the

packet signal there. A correlation value obtained by desreading processing is integrated for a predetermined period and the integrated value is sent to level detection section 404.

5           Level detection section 404 performs level detection processing on the input integrated value. For example, level detection section 404 compares the integrated value with a predetermined threshold and sends the comparison result to ON/OFF control section  
10 405. In this way, performing level detection makes it possible to extract the signal spread/modulated using a specific spreading code from the reception signal.

          Upon acquiring a comparison result that the integrated value exceeds a predetermined threshold,  
15 ON/OFF control section 405 turns ON switches 406, 407a and 407b and performs interference canceller processing on the reception signal. At this time, switch 407a is switched so that the reception signal is sent to 1st stage interference canceller 409, switch 406 is switched so  
20 that the reception signal is sent to 2nd stage interference canceller 410 and switch 407b is switched so that the reception signal is not sent directly to the CEIGU on the lowermost processing line.

          On the other hand, upon acquiring a comparison  
25 result that the integrated value falls below the predetermined threshold, ON/OFF control section 405 turns OFF switches 406, 407a and 407b and demodulates the reception signal without performing interference

canceller processing. At this time, switch 407a is switched so that the reception signal is not sent to 1st stage interference canceller 409, switch 406 is switched so that the reception signal is not sent to 2nd stage interference canceller 410 and switch 407b is switched so that the reception signal is sent directly to the CEIGU of the lowermost processing line.

The interference canceller processing in each interference canceller is the same as the interference canceller processing in Embodiment 1.

Furthermore, the level detection timing on a packet signal is controlled by timing control section 414. Since a control signal (AICH, etc.) that enables transmission of an uplink packet signal is sent by the base station itself, the packet reception timing can be predicted from that transmission timing. That is, as shown in FIG.5, since time t from the timing of transmitting AICH from the base station to the communication terminal to the timing at which the packet signal arrives at the base station is predictable at the base station, level detection of the packet signal is performed at the timing at which the packet signal arrives at the base station. That is, ON/OFF control of the interference canceller is started when a predetermined time has passed after the AICH transmission timing.

Thus, the present invention monitors the transmission timing of a control signal about a channel



that executes the interference canceller through level detection, detects the presence or absence of a channel (target channel) that executes the interference canceller and performs interference canceller

5 processing only when the target channel exists. That is, the present invention performs ON/OFF control of interference canceller processing based on the detection result about the presence or absence of the target channel. In this way, it is possible to perform  
10 interference canceller processing only on a specific packet signal. Since a spreading code used for a specific packet signal is notified from the communication terminal or already known, only a small amount of communication is required for notification of  
15 the spreading code even if the spreading code is notified from the communication terminal.

Moreover, since interference canceller processing is performed only on a specific spreading code, it is possible to reduce the number of channels  $k-1$  whose  
20 interference is to be eliminated. Thus, the hardware scale can be drastically reduced compared to the conventional MUD interference canceller. Furthermore, even if the spreading code is notified from the base station, only a small amount of communication is required  
25 for notification of the spreading code.

In a packet communication, the present invention can also be applied to a case where transmission directivity control is performed using an adaptive array

antenna or smart antenna as in the case of Embodiment  
1. A packet signal sent with specific directivity  
constitutes considerable interference to a channel  
exchange type signal (communicated through a channel  
5 such as a voice signal or high-speed image transmission  
signal) with identical directivity.

Therefore, as shown above, by detecting the level  
of a specific packet signal and performing ON/OFF control  
of interference canceller processing based on the  
10 detection result, it is possible to perform interference  
canceller processing only on the packet signal sent with  
specific directivity, which constitutes considerable  
interference to the channel exchange type signal. As a  
result, interference with the channel exchange type  
15 signal can be reduced.

The radio reception apparatus of the present  
invention has a configuration including a detection  
section that detects a reception signal spread/modulated  
using a specific spreading code from a reception signal  
20 and an interference canceller that performs interference  
canceller processing about the detected reception  
signal.

The radio reception apparatus of the present  
invention in the configuration above has a configuration  
25 in which the extraction section measures the reception  
level of a reception signal and extracts a reception  
signal spread/modulated using a specific spreading code  
from this measurement result.

According to these configurations, since interference canceller processing is performed only on a specific spreading code, interference canceller processing can be performed with the reduced hardware scale compared to conventional arts. Moreover, only a small amount of communication is required for notification of the spreading code even if the spreading code is notified from the other end of communication. As a result, it is possible to obtain desired reception data with extreme ease and with improved SIR.

The radio reception apparatus of the present invention has a configuration including a reception level measurement section that measures the reception level of a reception signal spread/modulated using a spreading code, a control section that controls execution/non-execution of interference canceller processing according to the reception level and an interference canceller that eliminates the interference component from the reception signal when the interference canceller processing is performed.

The radio reception apparatus of the present invention in the configuration above has a configuration in which when the reception level of the reception signal exceeds a predetermined threshold, interference canceller processing is performed on the reception signal.

According to these configurations, a channel on which the interference canceller is executed is

monitored through level detection and interference  
canceller processing is performed only on a specific  
channel. Since interference canceller processing is  
performed only on a specific spreading code, only a small  
5 amount of communication is required for notification of  
the spreading code even if the spreading code is notified  
from the other end of communication. This allows  
interference canceller processing to be performed with  
the reduced hardware scale. As a result, desired  
10 reception data can be obtained with improved SIR.

The radio reception apparatus of the present  
invention in the configuration above has a configuration  
in which when the reception signal is a packet signal,  
control of execution/non-execution of interference  
15 canceller processing is started at timing at which the  
packet signal is received.

According to this configuration, interference  
canceller processing can be performed only on a specific  
channel on the downlink and desired reception data can  
20 be obtained with improved SIR.

The radio reception apparatus of the present  
invention in the configuration above has a configuration  
in which when the reception signal is a packet signal,  
control of execution/non-execution of interference  
25 canceller processing is started when a predetermined  
time has passed after the transmission timing of a  
control signal sent before the packet signal is sent.

This configuration allows interference canceller

processing to be performed only on a specific channel and makes it possible to obtain desired reception data with improved SIR.

The communication terminal apparatus of the present invention is characterized by provision of the radio reception apparatus in the above configuration. Furthermore, the base station apparatus of the present invention is characterized by provision of the radio reception apparatus in the above configuration.

According to these configurations, it is possible to perform interference canceller processing with reduced hardware scale and thereby obtain desired reception data with improved SIR.

The radio reception apparatus of the present invention includes a step of measuring the reception level of a reception signal spread/modulated using a spreading code and a step of performing interference canceller processing on the reception signal when the reception level of the reception signal exceeds a predetermined threshold and eliminating the interference component from the reception signal, and when the reception signal is a packet signal, starts measurement of the reception level of the reception signal at timing at which the packet signal is received.

According to this method, a channel on which the interference canceller is executed is monitored through level detection and interference canceller processing is performed only on a specific channel in this way. This

makes it possible to perform interference canceller processing only on a specific channel on the downlink and obtain desired reception data with improved SIR.

The radio reception method of the present invention includes a step of measuring the reception level of a reception signal spread/modulated using a spreading code and a step of performing interference canceller processing on the reception signal when the reception level of the reception signal exceeds a predetermined threshold and eliminating the interference component from the reception signal, and when the reception signal is a packet signal, starts measurement of the reception level of the reception signal when a predetermined time has passed after the transmission timing of a control signal sent before the packet signal is transmitted.

According to this method, a channel on which the interference canceller processing is executed is monitored through level detection and interference canceller processing is performed only on a specific channel. This makes it possible to perform interference canceller processing only on a specific channel on the uplink and obtain desired reception data with improved SIR.

The present invention is not limited to the embodiments described above, but can be implemented with various modifications. There are no particular restrictions on the number of processing line stages in the interference canceller and the number of stages.

Furthermore, as the method of extracting a signal spread with a specific spreading code from the reception signal, Embodiments 1 and 2 above describe the method by which the reception level is measured and the signal is

5 extracted based on this measurement result. However, the present invention can also use other methods of extracting a signal spread with a specific spreading code from the reception signal.

As described above, the radio reception apparatus  
10 and radio reception method of the present invention perform interference canceller processing only on a specific spreading code, making it possible to perform interference canceller processing with reduced hardware scale. This also allows desired reception data to be  
15 obtained with improved SIR.

This application is based on the Japanese Patent Application No.HEI 11-236322 filed on August 24, 1999, entire content of which is expressly incorporated by reference herein.

20

#### Industrial Applicability

The present invention can be applied to a base station apparatus and communication terminal apparatus in a digital radio communication system.

What is claimed is:

1. A radio reception apparatus comprising:

detecting means for detecting a reception signal  
spread/modulated using a specific spreading code from  
5 the reception signal; and

an interference canceller that performs  
interference canceller processing on the detected  
reception signal.

2. The radio reception apparatus according to claim  
10 1, wherein the detecting means measures the reception  
level of the reception signal and extracts the reception  
signal spread/modulated using a specific spreading code  
from this measurement result.

3. A radio reception apparatus comprising:

15 reception level measuring means for measuring the  
reception level of a reception signal spread/modulated  
using a spreading code;

controlling means for controlling  
execution/non-execution of interference canceller  
20 processing according to said reception level; and

an interference canceller that eliminates the  
interference component from said reception signal when  
said interference canceller processing is performed.

4. The radio reception apparatus according to claim  
25 3, wherein when the reception level of said reception  
signal exceeds a predetermined threshold, interference  
canceller processing is performed on said reception  
signal.



5 5. The radio reception apparatus according to claim  
3, wherein when said reception signal is a packet signal,  
control of execution/non-execution of said interference  
canceller processing is started at timing at which said  
packet signal is received.

10 6. The radio reception apparatus according to claim  
3, wherein when said reception signal is a packet signal,  
control of execution/non-execution of said interference  
canceller processing is started when a predetermined  
time has passed after the transmission timing of a  
control signal sent before said packet signal is  
transmitted.

15 7. A communication terminal apparatus equipped  
with a radio reception apparatus, said radio reception  
apparatus comprising:

detecting means for detecting a reception signal  
spread/modulated using a specific spreading code from  
the reception signal; and

20 an interference canceller that performs  
interference canceller processing on the detected  
reception signal.

8. A base station apparatus equipped with a radio  
reception apparatus, said radio reception apparatus  
comprising:

25 detecting means for detecting a reception signal  
spread/modulated using a specific spreading code from  
the reception signal; and

an interference canceller that performs

interference canceller processing on the detected reception signal.

9. A radio reception method comprising the steps of:

5       measuring the reception level of a reception signal spread/modulated using a spreading code;

performing interference canceller processing on said reception signal when the reception level of said reception signal exceeds a predetermined threshold and  
10       eliminating the interference component from said reception signal, wherein when said reception signal is a packet signal, measurement of the reception level of said reception signal is started at timing at which said packet signal is received.

15       10. A radio reception method comprising the steps of:

measuring the reception level of a reception signal spread/modulated using a spreading code;  
performing interference canceller processing on said  
20       reception signal when the reception level of said reception signal exceeds a predetermined threshold and eliminating the interference component from said reception signal, wherein when said reception signal is a packet signal, measurement of the reception level of  
25       said reception signal is started when a predetermined time has passed after the transmission timing of a control signal sent before said packet signal is transmitted.

## ABSTRACT

A received common control channel signal is subjected to predetermined radio reception processing, sent to matched filter 103 and subjected to despreading processing there. Regarding a correlation value obtained by despreading processing, its integrated value is sent to level detection section 104. Level detection section 104 performs level detection processing on the input integrated value. Upon acquiring a comparison result that the integrated value exceeds a predetermined threshold, ON/OFF control section 105 turns ON switches 106, 107a and 107b and performs interference canceller processing on the reception signal.

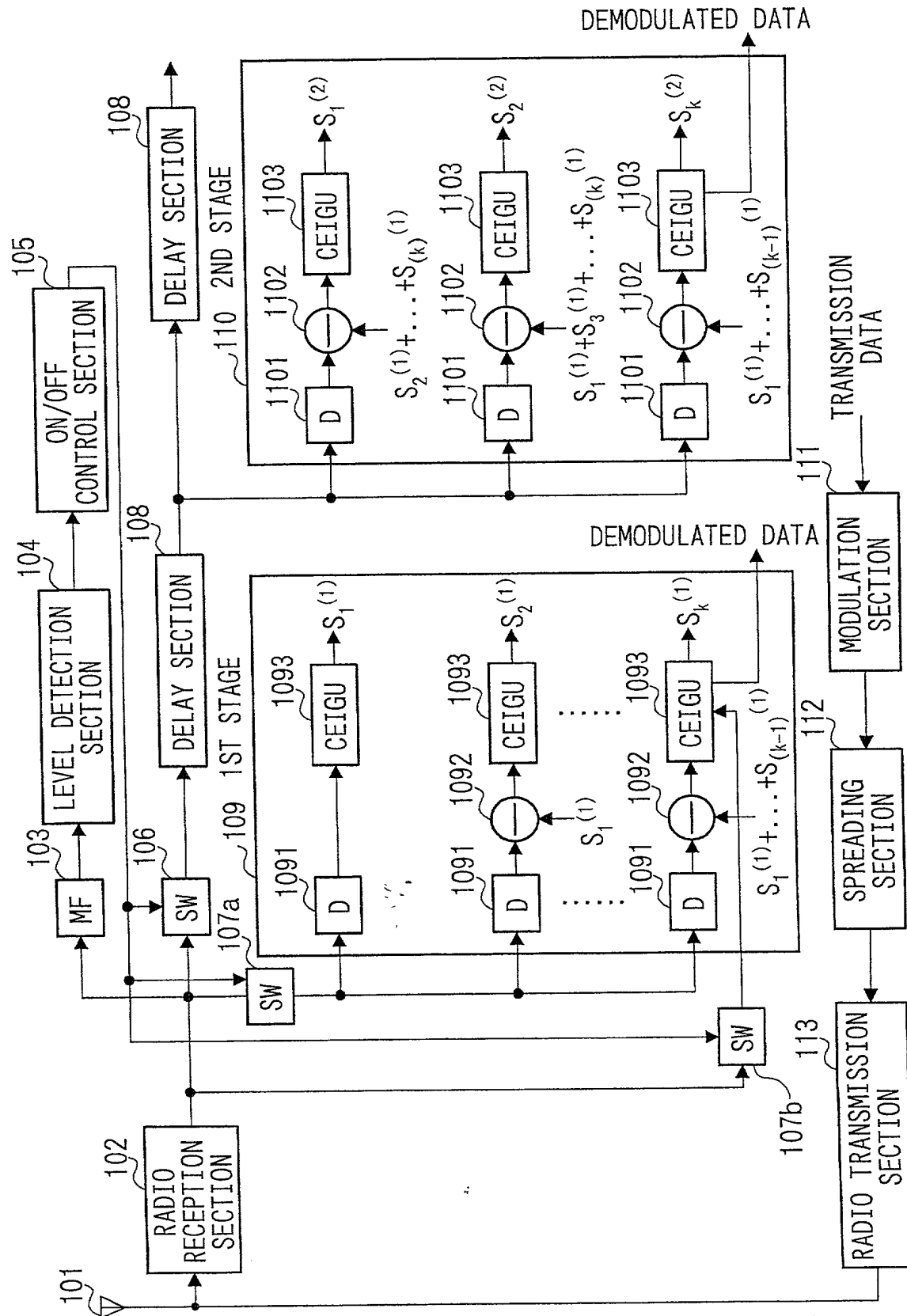


FIG. 1

2 / 5

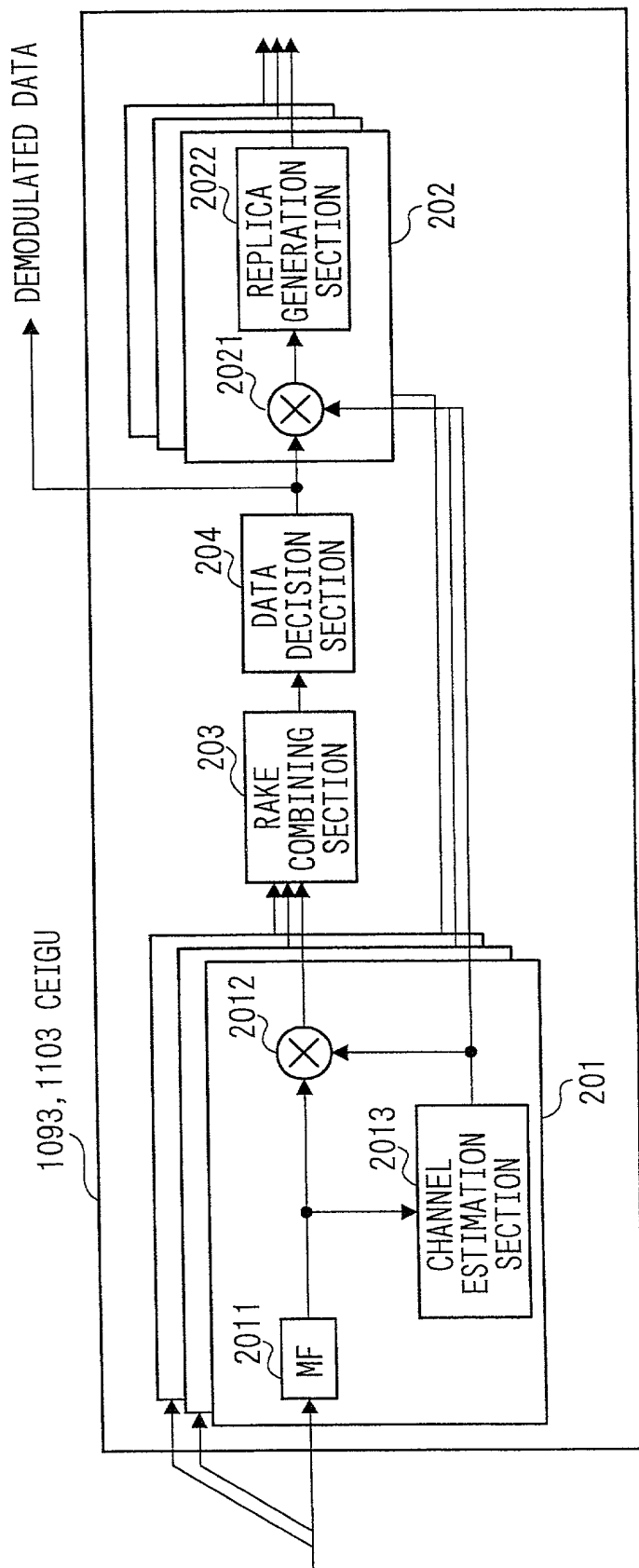


FIG. 2

3 / 5

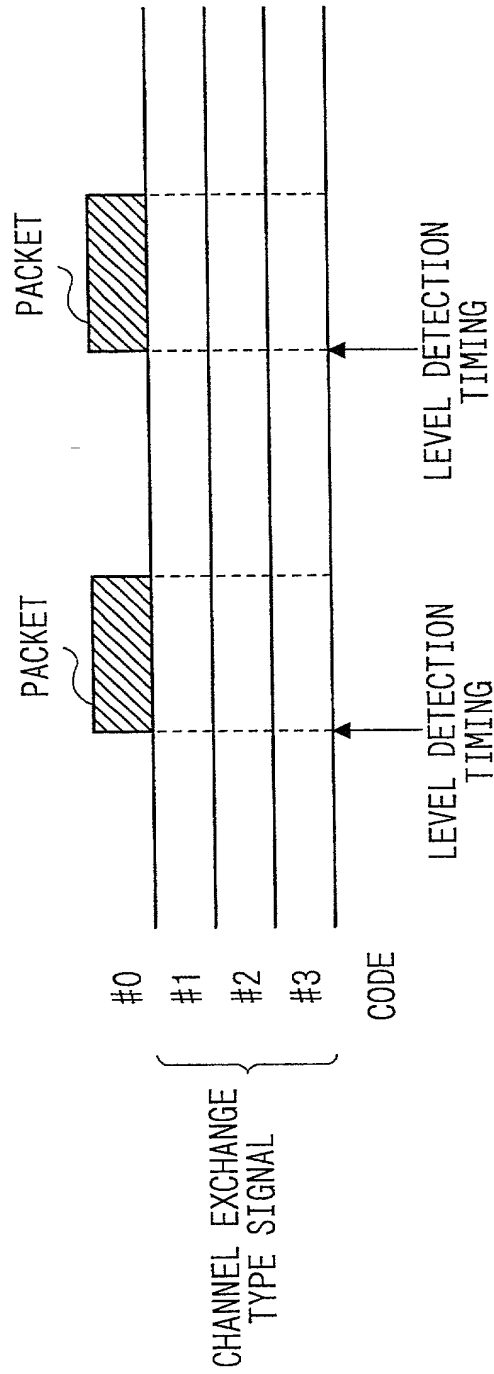


FIG. 3

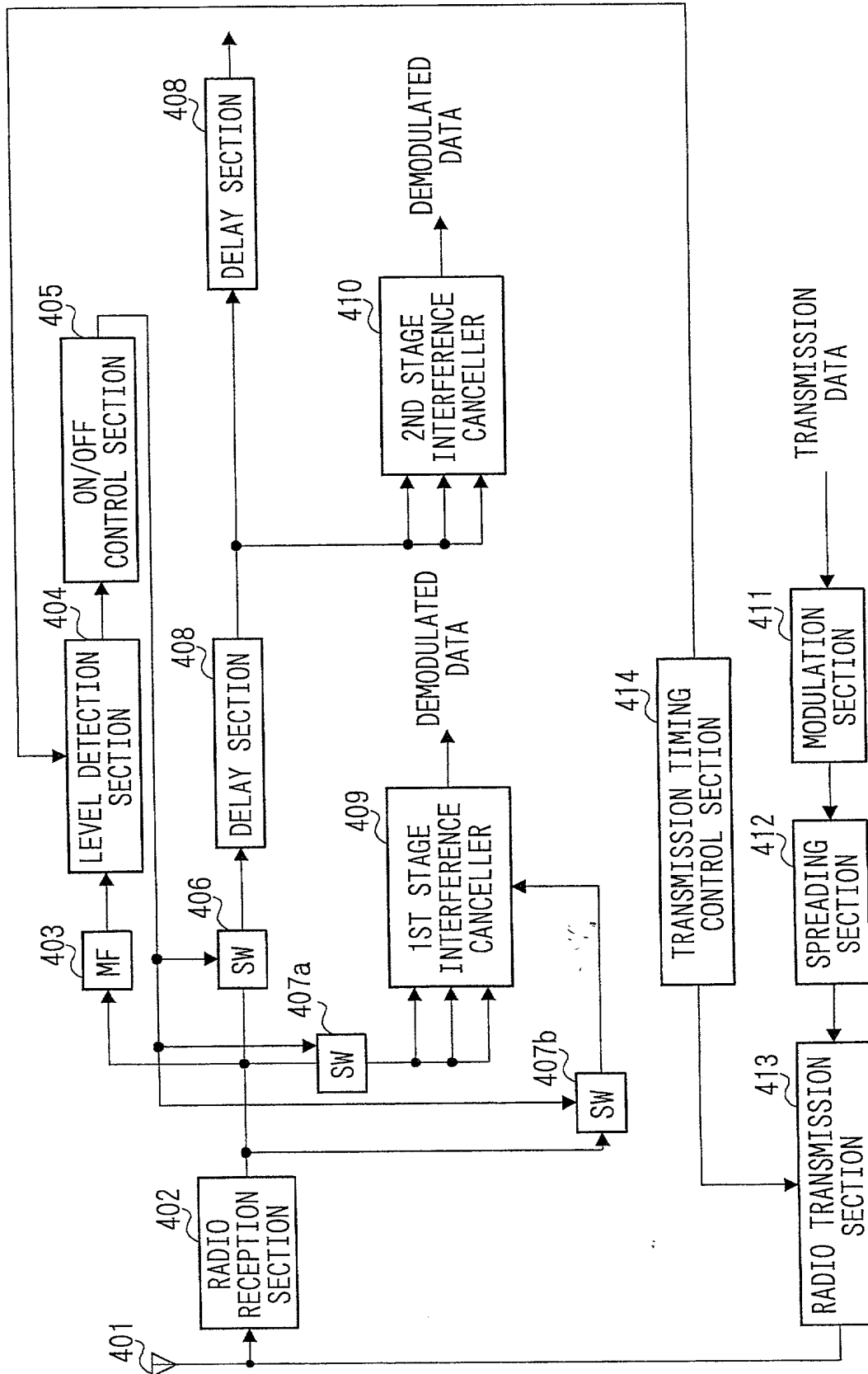


FIG. 4

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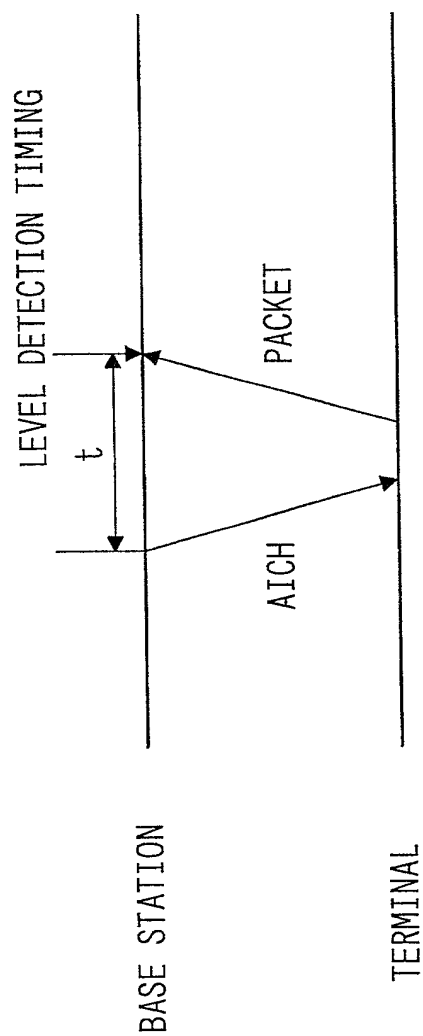


FIG. 5



# APPLICATION FOR UNITED STATES PATENT

## Declaration for Patent Application

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on

the invention entitled: RADIO RECEPTION APPARATUS AND RADIO RECEPTION METHOD

the specification of which 2 (file no \_\_\_\_\_)

(check at least one)

3 ☒ is attached hereto

4 ☐ was filed on \_\_\_\_\_ as (5) U.S. Application Serial No. \_\_\_\_\_

6 ☐ and was amended \_\_\_\_\_  
(if applicable)

Use this portion only if you are entering the U.S. National phase based on a PCT International Application designating the U.S.	7 [ x ]	was filed as PCT international application
	8	Number <u>PCT/JP00/05598</u>
	9	on <u>August 22, 2000</u>
		and was amended under PCT Article(s) 19 and/or 34
	10	on _____ (if applicable).
	11	priority date claimed in PCT International Application
		<u>JAPAN</u> <u>JP11-236322</u> <u>24/August/1999</u>
		(Country)                      (Number)                      (Day/Month/Year Filed)

I hereby declare that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended, by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me which is material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application (s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date earlier than that of the application(s) on which priority is claimed.

Prior (Foreign) Application(s) any Priority Claims Under 35 U.S.C. 119 Priority Claimed

12a \_\_\_\_\_ [ ] [ ]  
(Country) (Number) (Day/Month/Year Filed) Yes No

\_\_\_\_\_ [ ] [ ]  
 (Country) (Number) (Day/Month/Year Filed) Yes No

Priority Claim(s) from U.S. Provisional Application(s) – I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below:

12b	Application No.	Day/Month/Year Filed	Application No.	Day/Month/Year Filed

<p>Do not use this portion to identify a PCT application if the parent application is the U.S. National phase of the PCT application</p>	<p>I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between filing date of the prior application and the national or PCT international filing date of this application.</p>		
	<p>13 _____ (U.S. Application Number)</p>	<p>_____ (U.S. Filing Date)</p>	<p>_____ Status (patented, pending, abandoned)</p>

I hereby appoint the following attorneys of the firm of Stevens, Davis, Miller & Mosher, L.L.P. as my attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent and Trademark Office:

James E. Ledbetter, Reg. No. 28732; Thomas P. Pavelko, Reg. No. 31689; and Anthony P. Venturino, Reg. No. 31674.

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TELEPHONE (202) 408-5100, FACSIMILE (202) 408-5200.**

**See page 2 for signature lines**

**STEVENS, DAVIS, MILLER & MOSHER, L.L.P.**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful statements may jeopardize the validity of the application or any patent issuing thereon.

**PAGE 2 OF U.S.A. DECLARATION FORM**

14a	Typewritten Full Name of Sole or First Inventor	<u>Kazuyuki</u>	<u>MIYA</u>
		Given Name	Middle Name
15a	Inventor's Signature	<u>Kazuyuki</u>	<u>Miya</u>
16a	Date of Signature	<u>March</u>	<u>23</u>
		Month	Day
			<u>2001</u>
		Year	
17a	Residence	<u>Kawasaki-shi</u>	<u>Kanagawa</u>
		City	State or Province
			<u>JAPAN</u>
			Country
18a	Citizenship	<u>JAPAN</u>	
19a	Post Office Address (Insert complete mailing address, including country)	<u>5-26-25, Kamiasao, Asao-ku,</u>	
		<u>Kawasaki-shi, Kanagawa 215-0021 JAPAN</u>	
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			Family Name
15b	Inventor's Signature		
16b	Date of Signature	Month	Day
			Year
17b	Residence	City	State or Province
			Country
18b	Citizenship		
19b	Post Office Address (Insert complete mailing address, including country)		
14c	Typewritten Full Name of Sole or First Inventor	Given Name	Middle Name
			Family Name
15c	Inventor's Signature		
16c	Date of Signature	Month	Day
			Year
17c	Residence	City	State or Province
			Country
18c	Citizenship		
19c	Post Office Address (Insert complete mailing address, including country)		
14d	Typewritten Full Name of Sole or First Inventor	Given Name	Middle Name
			Family Name
15d	Inventor's Signature		
16d	Date of Signature	Month	Day
			Year
17d	Residence	City	State or Province
			Country
18d	Citizenship		
19d	Post Office Address (Insert complete mailing address, including country)		